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PHYSICAL AND MOTOR ABILITY CORRELATES OF EXTREME SOCIOECONOMIC GROUPS, GRADE ONE BOYS, EDMONTON, ALBERTA

by

© VALERIE R. HUNT

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Physical and Motor Ability Correlates of Extreme Socioeconomic Groups, Grade One Boys, Edmonton, Alberta" submitted by Valerie R. Hunt in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

The purpose of this study was to investigate the motor ability and physical growth of two groups of grade one Edmonton boys, extreme with regard to socioeconomic status. Eighty-one subjects participated in the study: forty-four in the high socioeconomic group, and thirty-seven in the low socioeconomic group. Subjects were selected from six schools assigned by the Edmonton Public School Board. Schools were situated in seemingly extreme high and low socioeconomic districts in Edmonton.

The following motor ability tests were administered in the schools:

1. Flexed arm hang
2. Hand grip strength - non-preferred hand
   - preferred hand
3. Manual dexterity - full board
   - partial
4. Shuttle run
5. Standing broad jump
6. Stork stand - eyes closed
   - eyes open

Evaluation of growth was based on the structural measures of standing height, weight and chest girth, and the maturation measures of chronological age and skeletal age. Hand-wrist x-rays, interpreted by physicians at the University Hospital in Edmonton, were employed in the assessment of skeletal age.

Means, standard deviations and intercorrelation matrices were computed for the total experimental group, high and low socioeconomic groups,

and high and low skeletal age groups. For all tests of significance of difference between group means and correlations, the .05 level was accepted.

The following conclusions were warranted:

1. This investigation substantiated previous studies, in that the relationship among motor ability tests was meaningful but low.
2. Measures of structure and maturation were significantly and positively related. However, a degree of independence between these two aspects of growth was apparent.
3. Motor ability was not significantly related to structure or maturation for the subjects in this study. The high skeletal age group did exceed the low skeletal age group in the shuttle run and hand grip motor ability tests. However, these motor ability differences could not be attributed directly to the skeletal age difference, as the high skeletal age group also had a significantly higher mean chronological age.
4. Within the limitations of this study, grade one boys from extreme socioeconomic environments in Edmonton did not differ significantly in motor ability or growth.

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CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

The development of motor skills begins at birth and may continue well into adulthood. Some aspects of motor performance may be considered to be 'basic', others 'specific'. Basic aspects, supposedly necessary for the performance of a wide variety of activities, may be called 'abilities', while specific aspects, appropriate only to the activity for which they were developed, may be referred to as 'skills' (Fleishman, 1964).

Larson and Yocom (1951) conceived of motor performance in terms of three hierarchical levels. The first and most general level is comprised of elements or factors (abilities) such as strength, flexibility, agility, balance, speed and coordination. Included in the second level are the abilities (often termed 'fundamental skills') of running, jumping, throwing, climbing, vaulting, catching and kicking. The third level consists of specific sports activities: for example, swimming and tennis. Performance on tests of first and second level abilities has been considered to indicate 'general' motor development level, sometimes referred to as motor ability. There may be a relationship between performance on the first two levels and performance on the third level. However, motor performance appears to be highly specific (Henry, 1956), and the possibility of a single general motor ability factor is no longer acceptable (Fleishman, 1964). Motor ability may perhaps best be considered as a sampling of the relatively independent motor abilities possessed (Henry, 1958).

The motor development of children in their first four or five years of life is easily observed, as many 'second level' motor abilities are being exhibited for the first time. For this age group, motor achievement age norms exist, and motor performance is employed as an index of intellectual as well as physical development.

The six year old child, however, can perform most of the second level abilities with some degree of proficiency (Gutteridge, 1939). Between the ages of six and twelve, the child is in a period marked by slow physical developmental change (Espenschade, 1967, p. 137),

> ... a time of rapid learning and what may be thought of as growth consolidation, characterized more by the perfection and stabilization of previously acquired skills and abilities rather than the emergence of new ones.

During this period of life, known as later childhood, the child's motor performance steadily improves. Improvement in quality of movement is obvious; however, quality of performance is not easily measured. Evaluation of motor ability is generally based on quantitative information. Commonly used tests of motor ability are the dash, jump and reach, standing broad jump and distance throw.

Motor development parallels physical growth to a large extent. The developmental curves for motor ability tests resemble those for physical growth, revealing improvement with chronological age, at least until puberty (Espenschade, 1967). The slow, gradual improvement and increased adaptability of basic movement patterns during later childhood, is accompanied by constant, but relatively slow growth and physiological change. The relationship between motor ability and physical growth levels, however, is not clearly understood for young elementary

school children within a single age group.

Physical growth, which as a process, is thought to encompass all measurable physical and biological changes, may be considered in terms of the related aspects of structure and maturation (Frank, 1950). Measures of standing height, weight and chest girth may be included as structural measures. Maturation is a distinctive aspect of growth, as it relates to set patterns of qualitative change within human organ systems. Skeletal maturation, expressed as skeletal age and commonly based on roentgenographic study of the degree of ossification in the hand and wrist bones, is the most frequently used indicator of (physiological) maturation (Tanner, 1961).

Motor development and physical growth are influenced by the environment (Tanner, 1961; Fleishman, 1964). Social classes (strata) are considered to be a valid source of environmental distinction in sociological study (Reissman, 1959). Characteristic environmental differences have been associated with the various socioeconomic strata. Social class appears to have widespread influence on many aspects of life, including nutrition, physical health and type of physical activity engaged in. It is therefore possible to hypothesize that growth and motor ability levels differ for children of the same age, from different socioeconomic environments. There is evidence to support such an hypothesis. Decreased growth levels have been attributed to children, particularly boys, from poor socioeconomic circumstance (Acheson and Fowler, 1964). Children from low socioeconomic environments have been found to excel in certain motor tests, and upper class children to excel in others (Ponthieux and Barker, 1965). However, information concerning

the influence of socioeconomic environment on motor ability is sparse and inconclusive.

Problem

The present study is an investigation of motor ability and physical growth of two groups of grade one boys, from two extreme socioeconomic environments in Edmonton, Alberta, Canada.

Specific objectives are:

1. to investigate the relationships among motor ability and growth measures for the total experimental group.
2. to compare high and low socioeconomic groups on the basis of motor ability and growth.
3. to compare high and low skeletal age groups on the basis of motor ability and structural measures.

Physical growth measures are included so that in the event of motor ability differences between socioeconomic groups, the extent of influence of growth factors, as opposed to behavioral factors in the environment, can be estimated.

The relationship between growth and motor ability is not expected to be significant for the subjects in this study. The processes of growth and motor development proceed simultaneously with age. However, the relationship between growth and motor ability appears to be low for young children of a single age group (Rarick and Oyster, 1964).

Limitations of the study

1. Selection of subjects was not completely random. Elementary schools from which subjects were drawn were assigned by the Edmonton Public School Board. Of the children available in the schools, only those for whom parental consent was received were tested.
2. For the purposes of the study, socioeconomic status of subjects was supported by socioeconomic characteristics of assigned school districts; information regarding socioeconomic characteristics was obtained from 1961 demographic records for Edmonton. Socioeconomic grouping, being ecologically based, was subject to error from the possibility, firstly, of change within districts since 1961, and secondly, of heterogeneity within the districts. Validity of generalization for the population of Edmonton and beyond is diminished by the chance of limited representativeness of the sample.
3. The motor ability tests selected for use in this investigation had been employed with success in previous studies. However, motor ability testing is, at best, of questionable validity.
4. The accuracy of x-ray interpretation was limited to within three to six months (Greulich and Pyle, 1959).
5. Cross-sectional data is of limited value in the study of growth. Due to wide normal variation in individual growth patterns, rates of growth are more informative than are levels of growth. A similar limitation applies to the cross-sectional study of motor development.

Delimitations

1. Eighty-one six and seven year old boys were subjects for the study; thirty-seven subjects were members of the low socioeconomic group, and forty-four were members of the high socioeconomic group.
2. The range of motor abilities investigated was limited by the particular motor tests selected for inclusion in the motor ability test battery.
3. No measure of test or subject reliability was used. Estimates of test reliability, available from other studies, are included in Appendix D.
4. For motor ability testing, no attempt was made to control for differences among subjects in motivation and previous learning.

Definition of terms

The definitions expressed hereunder are applicable only for the purposes of this investigation.

Growth. The term growth was used to denote the measurable physical and physiological characteristics of the subjects as assessed by the structural and maturation measures employed.

Maturation. Maturation was defined as that aspect of growth related to set patterns of qualitative change in all bodily organ systems. Assessment of maturation was based on chronological age and, in particular, skeletal age.

Motor ability. Motor ability has been defined as "the present acquired

and innate ability to perform motor skills of a general or fundamental nature [abilities], exclusive of highly specialized sports or gymnastics techniques" (Barrow and McGee, 1964, p. 122). Motor ability was operationally defined to denote the particular sample of motor abilities measured by the battery of motor tests employed. The tests used in this study were employed to measure the factors of explosive, static and dynamic strength, balance and manual dexterity, and the selected gross motor abilities of running and jumping.

Skeletal age. Skeletal age is a measure of (skeletal) maturation based on the degree of ossification of hand and wrist bones. "Skeletal age corresponds to the chronological age at which the children on whom the standards were based usually attained that same degree of skeletal development" (Greulich and Pyle, 1959, p. 28). Greulich-Pyle standards of skeletal development were employed in skeletal age assessment.

Structure. Structure was defined as the morphological expression of growth as determined by measures of standing height, weight and chest girth.

Social stratification. Social stratification has been defined (Tumin, 1967, p. 12) as "the arrangement of any social group or society into a hierarchy of positions that are unequal with regard to power, property, social evaluation, and/or psychic gratification".

Socioeconomic status. Socioeconomic status of a group is the position of that group within the hierarchy of social groups. The socioeconomic status of experimental groups in this study was impressionistically supported by demographic information concerning education, annual income and occupation for adult males in the subjects' districts of residence.

Low and high socioeconomic groups were distinguished by observable numerical differences in demographic data for these three socioeconomic variables; higher levels of education, greater annual income and greater occupational prestige were attributed to male residents in high socioeconomic districts.

CHAPTER II

REVIEW OF LITERATURE

The literature considered relevant to this investigation has been partitioned into six main areas. In order of appearance below, these partitions are, (a) motor ability, (b) physical growth, (c) relationship between motor ability and physical growth, (d) influence of environment, social strata and socioeconomic status, (e) relationship of socioeconomic status to motor ability, (f) relationship of socioeconomic status to physical growth.

a. Motor ability

Widespread belief in the generality of motor performance was prevalent well into the 1950's. Such a belief appealed greatly to physical educators who recognized the value in the homogeneous grouping of pupils for activity. The supposed existence of a general motor ability factor, or general motor coordination, seemed to be supported by the reality of the 'natural athlete' and the 'motor moron'. However, relationships among motor ability tests have been consistently low, and the concept of a single general motor ability factor is no longer tenable (Fleishman, 1964). Franklin Henry became a major figure in the generality-specificity issue. According to Henry (1956, p. 69), "it is largely a matter of chance whether an individual who is highly coordinated in one type of performance will be well or poorly coordinated in another." The 'natural athletes', Henry believes, are gifted with a large number of 'specific' abilities, and the 'motor morons' possess few or none of these abilities. Therefore, "the general motor factor which thus makes its appearance is

a sample, fundamentally, of how many specifics ['specific' motor abilities] the individual has, and general motor ability does exist in this sense" (Henry, 1958, p. 127).

Though performance in one physical activity is apparently not predictable from performance in another, the possibility remains that an hierarchy of elements, abilities (sometimes referred to as 'fundamental skills') and sports skills exists within motor performance (Larson and Yocom, 1951). Apparently assuming an hierarchy of some kind to exist, Gagné and Fleishman (1959, p. 94) state that basic abilities "represent stored general potentialities which can facilitate the learning of a variety of specific skills.... The individual who has a great many highly developed basic abilities can become proficient at a great variety of specific tasks". Perhaps motor ability, as operationally defined in this study, may be assigned a degree of generality in terms of such an hierarchical concept.

Elements thought to underly motor performance are commonly referred to as 'factors'. Attempted identification of motor performance factors has been a subject of research for over thirty years. Cozens (1929) suggested the following seven motor performance factors:

1. arm and shoulder girdle strength with some abdominal strength.
2. arm and shoulder girdle coordination.
3. hand-eye, foot-eye, arm-eye coordination.
4. jumping and leg strength.
5. endurance (sustained effort).
6. body coordination, agility, control.
7. speed of legs with coordination of body.

McCloy (1940) concluded from his research that there were ten motor factors. The factors proposed by McCloy were:

1. strength.
2. dynamic strength or energy.
3. ability to change direction.
4. flexibility.
5. agility.
6. peripheral vision.
7. good vision.
8. concentration.
9. understanding the mechanics of movement.
10. absence of disturbing emotional complications.

Most recently, Fleishman (1964) isolated nine 'motor fitness' factors. These were:

1. explosive strength.
2. static strength.
3. dynamic strength.
4. trunk strength.
5. extent flexibility.
6. dynamic flexibility.
7. gross body equilibrium.
8. balance-visual cues.
9. speed of limb movement.

The terms motor fitness and motor ability (motor performance) are apparently not synonymous (Alderman and Howell, 1969). However, there

appears at present to be considerable overlap between the factors and tests of motor fitness and those of motor ability.

Strength is an important factor in physical performance, whether it is considered under the heading of motor fitness or motor ability. The area of strength is, according to Fleishman (1964), the most clearly defined area in the factor analysis literature. A degree of generality has been applied to strength measurement, and it has been stated that grip strength provides a good indication of total body strength (Bookwalter, 1950). Jones (1949) found a high correlation between grip strength and other static strength measures for his pre-adolescent and adolescent subjects.

Strength increases with chronological age during childhood and adolescence (Metheny, 1941a; Meredith, 1935) and correlates reasonably well with measures of growth. Gates (1924) found that grip strength correlated .45 with height and .40 with weight, for fourth grade children. In a study by Metheny (1941b), grip strength correlated .75 and better with height, weight, and age of pre-school boys and girls. The relationship between strength and growth appears to be particularly significant around the period of pubescence (Crampton, 1944).

Since first proposed by Rogers in 1926, and later revised by McCloy and Young (1954), the Strength Index has been used and supported as a basis of athletic ability grouping (Clarke, 1967). As a result, strength tests have been employed frequently as measures of motor ability. Fleishman (1964) categorized many commonly used motor ability tests as tests of strength.

On the other hand, according to Espenschade (1967), correlations

between static strength and other motor ability measures have generally been low. She states that, "where relatively high relationships between static strength and motor ability measures have been found, these have usually involved multiple correlations of a number of events" (Espenschade, 1967, p. 155). In Carpenter's study (1942) of primary school boys, for example, 'total shoulder girdle strength' (the sum of right grip, left grip, pull and push) correlated .63 with an index combining weight and performance in the broad jump and shot put.

Fleishman (1964) reported a series of factors, other than those he included under the heading of physical fitness. This series consisted of factors such as multilimb coordination, reaction time, manual dexterity and arm hand steadiness, which may be referred to as components of 'psychomotor ability'. Manual dexterity, selected for testing in this study, was defined by Fleishman as involving arm-hand manipulation of fairly large objects under speed conditions.

Running, jumping and throwing, though different from motor factors as they involve coordination of movement, are often considered to underly the performance of many sports activities (Larson and Yocom, 1951; Johnson, 1960). A degree of generality is usually assigned to these three movement patterns and, for the purposes of this thesis, they are thus referred to as abilities. Sometimes included on the hierarchical level of running, jumping and throwing abilities, are the following: grasping, striking, relaying objects, catching, kicking, hopping, and quick changes of body position (Espenschade, 1967).

Measurement of motor ability involves the testing of motor abilities and factors. Many tests of abilities and factors overlap. Perhaps

the prime criterion for a motor ability test is that norms for the test must indicate the motor development process by revealing improvement of scores with increasing age, at least until puberty. Additional criteria for a motor ability test are size of correlation with a larger battery of items, distribution of scores, objectivity, reliability and ease of administration. Examples of motor ability tests are: jumping for height or distance, running for speed, throwing for distance or accuracy, pull-ups, hand grip, and walking board balance tests (Espenschade, 1967). Motor ability (motor fitness or performance) test batteries have been devised for males and females of all ages. Recent ones include the American Association for Health, Physical Education and Recreation Fitness Battery (1965), the California Physical Performance Battery (1962), and the Canadian Association for Health, Physical Education and Recreation Fitness-Performance Test Battery (1966). Keogh (1965) has stated that most motor test batteries have included running, jumping and strength tests.

b. Physical growth

Patterns of growth are highly individual and there is a wide range of normal variation in developmental level at any one age (Tanner, 1961; Johnson, 1964). Chronological age, though the basis of developmental norms, is therefore not a satisfactory index of growth.

Physical growth may be considered in terms of two aspects, referred to in this study as structure and maturation (Frank, 1950).

As operationally defined, structure relates to the morphological expression of growth. Structural assessment usually involves the use of

anthropometric measurement. Height and weight were considered by Todd (1937) to be the best anthropometric measures of "physical developmental growth" during childhood. Oyster (1961) found a correlation of .78 between height and weight, for second grade children. Clarke and Carter (1959) found a correlation of .92 between body weight and chest girth. Of these three measures, height, weight and chest girth, height is generally the most informative in structural assessment (Tanner, 1961). Increases in weight and chest girth are difficult to interpret as they may reflect increases in bone, muscle and/or fat tissue.

Maturation, as a process, has been considered (Greulich and Pyle, 1959) to involve regular and irreversible patterns of genetically-controlled change in all bodily organ systems, patterns through which all members of a species must pass in proceeding from birth to maturity. Unlike changes in structure, maturational changes are qualitative, but not necessarily quantitative, in nature. Maturation appears to be a more stable aspect of growth than is structure (Todd, 1937). At the present time, the skeletal system is the organic system to which reference is most frequently made in the estimation of maturation. Skeletal maturation, expressed in terms of skeletal age, is commonly assessed by means of roentgenographic study of the hand and wrist bones.

Previous to 1937, Todd studied thousands of hand-wrist roentgenograms (x-rays) and noted a sequence of successive changes in outline and contour of ossification centres. A definite pattern of skeletal development was observed to persist until ossification was completed. In addition, Todd noted that all parts of the healthy skeleton develop in unison; degree of ossification of hand and wrist bones appeared to be a reliable

indicator of skeletal development throughout the entire body. On the basis of his work, Todd (1937) published an atlas of standards of hand-wrist skeletal development, intended for use in maturation assessment. There are different standards for men and women, as it is an accepted fact that the bones of the female ossify in advance of those of the male (Pryor, 1923). The Greulich-Pyle atlas (1959) provides improved standards for skeletal age assessment. In spite of the large subjective component in x-ray interpretation, reliabilities of approximately .90 have been reported by Todd (1937), Clarke and Degutis (1962), and Seils (1951). Trained assessors of unequal experience can usually rate within six months of each other, or better (Greulich and Pyle, 1959).

According to Greulich and Pyle (1959), skeletal age is the most useful single index of growth. Skeletal age certainly appears to be an acceptable maturation index. Burt (1962) found a correlation coefficient of .96 between skeletal age and the 'general maturity factor' he isolated.

Although structure and maturation may be considered as differing aspects of growth, a significant relationship between structural and maturation measures is to be expected. In a study by Hindmarch (1962), eight year old boys, advanced in skeletal age, were also advanced in body weight, standing height, upper arm girth, abdominal girth, buttocks girth and thigh girth. Burt (1962) reported correlations of approximately .70 between skeletal age and measures of sitting height, chest girth times height, standing height and body weight.

c. Relationship between motor ability and physical growth

Increases in structural and maturation measures are observed to

occur with age until maximum growth is attained. Similarly, motor ability improves with age until puberty, or in many cases, until maximum growth has been reached. The possibility of a positive relationship between growth and motor ability at any one age level seems plausible.

A relationship between structure and motor ability has been assumed to exist for classification purposes in physical education since the early 1900's. Various 'classification indices' have been devised for use in homogeneous motor ability grouping. These indices are formulas with different weightings for such variables as age, grade in school, height and weight. Carpenter (1942) found a substantial positive correlation between such a height-weight-age index and a composite score of athletic events, for children in grades one to three. The classification indices of Neilson and Cozens (1934) and McCloy (1932) appear to be among the most widely used.

Espenschade (Johnson, 1960) reported that when age was held constant, significant relationships resulted between weight and height, and measures of running, jumping and throwing, for boys aged ten to eighteen and girls aged ten to thirteen. However, her support for this statement consists of studies from the 1930's. More recent investigations have revealed positive, but low correlations, between motor ability tests and the structural measures of height and weight (Seils, 1951; Cearley, 1957; Barry and Cureton, 1961; Espenschade, 1963; Fleishman, 1964). Gross and Casciani (1962) concluded that height-weight-age classification indices were of little value in the homogeneous grouping of secondary school students, according to performance on the American Association for Health, Physical Education and Recreation Youth Fitness Test

Battery.

As discussed under physical growth, gains in structure, maturation and age parallel each other to a large extent. Rarick and Oyster (1964) and others (Seils, 1951; Oyster, 1961; Hindmarch, 1962) have found skeletal maturity to be of no more value than structure in explaining individual differences in the motor ability of young elementary school children within a narrow age range. However, structure and maturation appear to be more closely related to athletic performance during the pubescent years than during early childhood. A study by Hale (1956) revealed that the majority of boys in the Little League Baseball World Series were advanced in height, weight and maturation. Krogman (1959) found that 71% of the fifty-five boys in the 1957 Little League World Series had skeletal ages in advance of their chronological ages. In a study by Clarke and Petersen (1961), outstanding school athletes between the ages of ten and fifteen had a significantly more advanced structure and higher mean skeletal age than non-athletes of the same age.

Progress in growth usually reflects some improvement in muscle tissue. Growth increases, particularly in weight, are therefore, generally accompanied by increased strength (Tomaras, 1958; Clarke and Carter, 1959). An age-growth-strength relationship has been shown to exist for children of pre-school to late adolescent ages (Gates, 1924; Metheny, 1941; Crampton, 1944; Hindmarch, 1962; Rarick and Oyster, 1964).

d. Influence of environment, social strata and socioeconomic status

Children aged six and seven are in a period of slow, though constant growth (Tanner, 1961). Their body proportions remain much the same from

age six until the pre-pubertal growth spurt. This life period may be described as a time of growth and motor consolidation (Espenschade, 1967). The levels of physical growth and motor ability with which a child enters this 'plateau-like' period depend jointly upon inherited and environmental characteristics.

Socioeconomic status is one dimension, in sociological study, along which members of a population can be classified, and with which certain environmental and possibly some inherited characteristics can be associated (Reissman, 1959).

Socioeconomic status levels, or social classes, exist with varying degrees of formality in all modern industrial societies. They are, in this regard, one of the most basic and influential of the social categories. However, classes are not simply part of an abstract framework, imposed upon the community by the social analyst; they are intimately related to the value systems of the society and represent ways of life with definite characteristics and values (Warner, 1960). The concept of class is embedded within the ideology and institutions of the North American populace, and, as such, socioeconomic status is a reality for the members of North American society. Warner (1960) states, in reference to the United States, that social class is a major determinant of individual decisions and social actions. He further contends that every major area of American life is both directly and indirectly affected by class order. Social class has been shown to influence such variables as who one marries, kind and amount of education, personality, attitudes, beliefs, child rearing practices, consumer behaviour, physical health and fertility, and community participation (Reissman, 1959). In short,

'class' appears to permeate all parts of community existence. Social class is, therefore, a valid source of distinction in sociological study.

Although the orientation for judgment among people may differ, criteria for evaluating differences in socioeconomic status evidently exist (Reissman, 1959; Warner, 1960). The layman's criteria for evaluating socioeconomic status are similar to those employed by the sociologist. These include income, type of dwelling, material possessions, amount of education, reputation, lineage, and occupational prestige. However, the sociologist must assign people to classes more accurately than the layman. After extensive study of social class in the United States, Warner (1960) reported four main socioeconomic characteristics. These were: occupation, source of income, house type and dwelling area. Information concerning education and amount of income was also considered useful. In recent years, many methods of evaluating social class have been suggested, but they generally stem from Warner's criteria: for example, occupational prestige scales.

In addition to finding relevant criteria, the sociologist is constantly aware of the limitation that social class is not equal to any one or simple combination of the known criteria. Class is an extremely complex, multi-dimensional phenomenon with objective, subjective and reputational aspects (Reissman, 1959). Determination of actual class membership would necessitate combining, in some way, the above criteria and criteria not yet known.

Convenience, methodological restrictions, or lack of available information lead many investigators to distinguish among classes by reference to only one or two dimensions of socioeconomic status. On

occasion, this may apply to only a small number of criteria within one dimension, usually the objective dimension. Such studies, the present study included, are insensitive to the nuances of class distinction and may be subject to a great deal of error. However, in studies of an exploratory nature where such methodological limitations prevail, the findings are only intended to give direction to further more exacting research.

e. Relationship of socioeconomic status to motor ability

Espenschade (1967) emphasized the importance of opportunity in the development of motor ability. The availability of play equipment and facilities apparently varies for children in different socioeconomic environments. According to recent surveys, the size of play area and number of pieces of play equipment increase with family income (Cratty, 1967). On the basis of these findings, it may be hypothesized that children in the upper socioeconomic levels have greater opportunity to improve and increase their motor abilities and skills. On the other hand, lower class children are generally less supervised and less restricted in play space (Espenschade, 1940; Anderson, 1937). Also, they frequently exhibit 'creative adaptability' in their play activity. Anderson (1937) found no difference in the number of hours spent in play by children from different socioeconomic groups. Information on the comparative fitness and motor ability levels of children from different socioeconomic strata is scarce at the present time. Only three studies will be cited.

Bayley and Jones (1937) investigated the relationship between socioeconomic environment and the motor development of children between infancy and age six. The fine and gross motor ability tests employed

were adapted from the California Infant Scale of Motor Development. Socioeconomic criteria were family income, occupation of the father, and education of the mother and father. Correlations between socioeconomic status and motor test scores were low. However, the high incidence of negative correlations led the investigators to hypothesize that children from lower socioeconomic levels tended to experience an environment more stimulating to motor adaptive behaviour. The investigators suggested that children from upper socioeconomic levels were sheltered and given less incentive for independent action.

Ponthieux and Barker (1965) investigated the relationship between socioeconomic status and the physical fitness of boys and girls aged ten to twelve years. Socioeconomic status was based on a modified version of Warner's (1960) Index of Status Characteristics. The American Association for Health, Physical Education and Recreation Fitness Test Battery was used to measure physical fitness. All measures in the seven item test battery were correlated individually with socioeconomic measures. Significant relationships resulted. However, they did not indicate general superiority of high or low status groups. Low status females excelled in tests purporting to measure speed, coordination and endurance. High status females were better in tests of arm, shoulder, abdominal and hip flexor strength, and in items involving muscular explosiveness. Lower status males were superior in speed and coordination tests, while upper status males excelled in tests of agility and speed combined, and in abdominal and hip flexor strength items.

Williams and Scott (1953) used Negro infants, raised with upper and lower class families, as subjects in a study of socioeconomic status

and motor ability. They found a positive relationship between low socioeconomic status and motor acceleration.

f. Relationship of socioeconomic status to physical growth

Greulich and Pyle (1959) refer to a study by Dr. H.C. Stuart in which the mean skeletal age was below that in the Brush Foundation Study (Simmons, 1944). Greulich and Pyle attempted to explain the lower mean by adding that Stuart's sample included many children from less privileged homes than those in the Brush Foundation Study. The assumption made by Greulich and Pyle appears to be reasonable. There is evidence that children from low socioeconomic environments are not as well developed physically as upper class children.

Tanner (1961) reported structural differences between groups of children, of the same age, but from different socioeconomic environments. He states that differences of approximately one inch in height and one to eight pounds in weight have been found, consistently in favour of the upper socioeconomic groups.

Acheson and Hewitt (1954) studied structure and maturation of subjects from differing socioeconomic environments. Classification of environment was based on the father's occupation. Upper status boys had an advantage in structure and maturation over lower status boys. Larger differences were observed for structural than for maturation measures. Structure is apparently influenced to a greater extent by environment than is maturation. In addition, the lower class environment appeared to have a stronger and more lasting effect upon boys than upon girls.

The influence of socioeconomic environment on growth was also

studied by Acheson and Fowler (1964). The subjects were taken from two generations with a high standard of living, and from two generations with a low living standard. The investigators did not find a significant difference in rate of skeletal maturation between the high and low socioeconomic groups. However, male subjects with a high living standard grew faster, were taller and more mature at all ages, and had a greater predicted adult height. The results supported previous findings, in that skeletal maturation differed less than physical structure with variation in socioeconomic environment. And further, boys seemed to be more readily influenced than girls by environmental deprivation.

Results of a study by Stuart and Pyle *et. al.* (1962) support a direct relationship between retarded skeletal maturation and extremely low financial status. Their subject was a boy whose family suffered severe financial hardship from the time he was three until he reached the age of six. The boy's skeletal age was well below the mean during these years but gradually returned to the mean between the ages of six and ten, when the family's financial status was improved.

Socioeconomic environments undoubtedly vary in degree of physical deprivation, and hence, in the severity of detrimental influence. Socioeconomic environments may perhaps be arranged on a continuum of increasing and decreasing deprivation. One of the primary, but unknown factors in the present study is the degree of difference in 'circumstance' between the two socioeconomic groups employed.

g. Summary

The performance of physical activities, such as swimming and tennis,

appears to be highly specific to the activity. However, elements or factors (abilities), such as strength, flexibility and balance, and gross motor abilities, such as running and jumping, have been thought to underly motor performance.

Evaluation of motor ability usually involves tests of selected motor factors and/or gross motor abilities. Correlations among such tests have been consistently low, and it appears that motor ability may best be considered as a sample of the relatively independent motor abilities possessed.

Physical growth may be regarded in terms of the aspects of maturation and structure. Skeletal age, assessed by the comparison of a hand-wrist x-ray with standards, appears to be the most useful index of maturation presently available. Structure is commonly evaluated on the basis of such measures as height and weight. Measures of structure and maturation are considered to be complimentary in the evaluation of physical growth status.

Physical growth and motor development proceed simultaneously with age. However, neither structural nor maturation measures seem to be highly related to motor ability for young elementary school children within a narrow age range.

Amount of annual income, level of education, and occupational prestige appear to be acceptable socioeconomic characteristics, reasonably indicative of socioeconomic status level.

Differences in motor ability have been observed for extreme socioeconomic groups. However, there is not a clear relationship between motor ability and socioeconomic status.

High socioeconomic groups consistently exhibit superior physical

growth, compared to low socioeconomic groups. Growth differences between socioeconomic groups appear to be greater for structural than for maturation measures.

CHAPTER III

METHODS AND PROCEDURE

On the basis of the literature reviewed and outlined in Chapter II, the following research procedure was adopted.

Experimental design

In order to demonstrate whether or not the socioeconomic environment was exerting a beneficial or depressive influence upon upper and lower socioeconomic classes, a two group, two factor study was designed.

The groups in this case were taken from the extremes of the socioeconomic classes. If the implications of physical growth differences established in Chapter II were correct, then that fact should be readily evidenced in the extreme groups.

The two factors eventually used in this investigation, as indicators of socioeconomic environmental influence, were motor ability and physical growth. In the initial problem stated in Chapter I, differences in motor ability between high and low socioeconomic groups were considered to be possible outcomes of 'life' in those environments. Measures of physical growth, including hand-wrist x-rays, were employed to assist in the interpretation of data relating socioeconomic status and motor ability. A positive relationship was expected between growth and socioeconomic status.

Subjects

The Edmonton Elementary School Board granted permission for the

study, and assigned six public schools from which subjects could be drawn. Three schools were located within districts considered to be high socioeconomically, and three in reputedly low socioeconomic districts. Socioeconomic levels of assigned districts were impressionistically supported by 1961 demographic information concerning education, occupation and annual income of adult male residents (See Appendix A).

Principals and teachers in the assigned schools agreed to cooperate. Letters requesting permission were sent to parents of possible subjects attending the assigned schools. In all cases, the subjects selected were first grade males, aged six or seven years as of January 1, 1969. Samples of the letters sent to parents are included in Appendix B.

Complete data was recorded on eighty-one subjects. The result sheet employed is included in Appendix C. Forty-four of the subjects came from families residing in high socioeconomic districts, and thirty-seven from families residing in low socioeconomic districts. The majority of children were Caucasian. However, the sample did include seven non-white subjects: six children of Oriental descent and, one of Indian descent.

The chronological age range of subjects was 77 to 95 months. Chronological age for each subject was calculated up to the month in which the hand-wrist x-ray was taken.

Assessment of motor ability

Motor ability testing was conducted in the school situation. The testing environment varied slightly from school to school. However,

the space available was always adequate for proper testing.

The motor ability test battery eventually developed, based on a review of the literature, was as follows:

1. Flexed Arm Hang
2. Hand Grip Strength - preferred hand
   - non-preferred hand
3. Manual Dexterity - full board
   - partial
4. Shuttle Run
5. Standing Broad Jump
6. Stork Stand - eyes closed
   - eyes open

Tests were selected from a number of sources to measure strength, balance and manual dexterity factors (Fleishman, 1964), and the gross motor abilities of running and jumping. Other considerations in the selection of tests were capabilities of the particular age group, and time and equipment required.

For a complete description of each test, including source and purported factor, see Appendix D.

The investigator was accompanied by one assistant on each day of the motor ability testing. Four young adults, three male and one female, assisted with the motor ability testing on different occasions. Reliability of testing was most likely reduced by the unavoidable differences among test administrators. However, such assistance was necessary to provide test lengths that were not excessive.

Motor ability testing time was approximately twenty-five minutes per child. Two children were usually tested at the same time, each under the supervision of one administrator. Children wore street clothing, but were required to have bare feet for the performance of all motor ability tests.

The only attempt to control for motivational differences of the subjects was by the issuance of standardized verbal instructions and verbal encouragement during performance. However, if a child obviously did not perform well on a trial, another trial was allowed.

Assessment of physical growth

Chronological age, skeletal age and anthropometric measures were employed as indices of growth. Subjects were selected from one grade level to ensure a reasonably small chronological age range. Providing the mean chronological age for the groups was not significantly different, group differences in the remaining structural and maturation measures could be attributed to socioeconomic status.

Skeletal age, the primary maturation measure, was estimated from one x-ray of the left hand and wrist. The reference for method of assessment and standards of comparison was the Greulich-Pyle Radiographic Atlas of Skeletal Development of the Hand and Wrist (1959).

Skeletal x-rays were taken by qualified and registered x-ray personnel at the University Hospital in Edmonton. Children were transported to the hospital by special bus. A notice was sent home with the children the day before the visit to the hospital, informing their parents

of the arrangements. A copy of this letter is included in Appendix B.

Physicians at the University Hospital interpreted the x-rays. Independent assessments by two physicians were averaged to give the final skeletal age. Widely differing assessments resulted in a third joint assessment, with the assistance of the Director of Radiology, if necessary.

Structural assessment was based on the anthropometric measures of standing height, weight and chest girth. Height and weight measurement was conducted in the University Hospital, while the subjects were at the hospital for the x-ray. Height was measured in inches (taken without shoes on), to the nearest quarter inch. Weight was measured in pounds, to the nearest quarter pound.

Chest girth measurement was taken in the schools, at the time of motor ability testing, in accordance with the method described by the Committee on Nutritional Anthropometry of the Food and Nutrition Board (1956). A thin metal tape was employed. Measurement was to the nearest quarter inch.

Selected information was distributed to parents of subjects and to principals of participating schools.

CHAPTER IV

RESULTS AND DISCUSSION

The data collected from the eighty-one subjects was placed on I.B.M. cards, verified, then subjected to the calculations and analysis described hereunder.

Treatment of data

Means, standard deviations and correlations for motor ability and growth measures were computed for each socioeconomic group and for the combined groups.

Tests of significance employed in this study were a t-test for difference between means, and a similar test for difference between correlations, after transformation to z-functions. Differences in means and correlations between socioeconomic groups, and between each socioeconomic group and the combined (control) group, were tested for significance.

All subjects were then regrouped into a high or a low skeletal age section, and the above treatment of data repeated for these new groups.

For all tests of significance, $\alpha = .05$ was accepted.

Results and discussion

Success of motor ability testing was limited (Table I). Mean scores in this study for the flexed arm hang and shuttle run tests were inferior to those reported in the CAHPER Performance Test Manual (1966) for seven year old boys.

TABLE I

MEANS AND STANDARD DEVIATIONS OF ALL PARAMETERS FOR TOTAL EXPERIMENTAL GROUP

Parameter	Mean	Standard Deviation
1. Chest girth (inches)	23.47	1.22
2. Chronological age (months)	83.10	3.74
3. Flexed arm hang (seconds)	10.67 (22.9)*	8.73 (18.3)*
4. Grip strength - Non-preferred hand (kilograms)	9.45	2.17
5. Grip strength - Preferred hand (kilograms)	10.12	2.30
6. Height (inches)	47.72	1.96
7. Manual dexterity - Full board (seconds)	117.74	11.97
8. Manual dexterity - Partial (seconds)	20.32	2.34
9. Shuttle run (seconds)	15.80 (14.12)*	1.35 (1.29)*
10. Skeletal age (months)	71.56	11.17
11. Standing broad jump (inches)	44.63 (44.0)*	4.76 (7.0)*
12. Stork stand - Eyes closed (seconds)	6.94	4.49
13. Stork stand - Eyes open (seconds)	32.91	18.58
14. Weight (pounds)	51.49	6.82

* CAHPER Fitness-Performance Test norms for seven year old boys (Test Manual, 1966).

The standard deviation of the flexed arm hang and the stork stand tests were greater than one quarter of the mean. This indicated that the results of these tests were not stable. The results were most likely influenced by the use of different test administrators, as both of these tests have been used successfully in other studies.

A surprising result was the low mean skeletal age of the combined group (Table I). The mean skeletal age of 71.56 months was almost twelve months below the mean chronological age of 83.10 months. The Greulich-Pyle atlas (1959) reported skeletal age means of 88.2 months (Simmons, 1944) and 80.6 months (Stuart) for 84-month-old children.

In addition, the standard deviation of 11.17 months for skeletal age in this study was somewhat larger than those reported in other investigations. Standard deviations in the Brush Foundation and Stuart studies were 8.91 and 10.1 months respectively, for children aged 84 months. Stuart's sample included many children from less privileged homes than those in the Brush Foundation Study. This perhaps explains the fact that results of the present study resembled those of Stuart more closely than those of the Brush Foundation Study.

Fifty-three of the ninety-one correlations compared significantly with the null at the .05 level (Table II). The correlations were, however, generally low. Only three correlations were above .70. These three relatively high correlations were for weight and chest girth, height and weight, and preferred and non-preferred hand grip strength.

The following hypotheses were established on the basis of the literature, to answer in part, the problem as set out in Chapter I.

Hypothesis 1: The relationships among tests in the motor ability test

TABLE II

ZERO ORDER CORRELATIONS BETWEEN ALL PARAMETERS FOR TOTAL EXPERIMENTAL GROUP

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		.274	-.086	.546	.540	.621	-.265	-.183	-.275	.420	.188	.029	-.001	.840
2			-.039	.328	.285	.405	-.356	-.292	-.326	.331	.235	.131	.073	.219
3				.037	.058	-.079	-.075	.025	-.206	-.067	.123	.103	.316	-.116
4					.822	.534	-.224	-.176	-.458	.262	.340	.183	.256	.563
5						.585	-.200	-.122	-.404	.311	.235	.094	.153	.557
6							-.297	-.127	-.304	.535	.259	.012	.037	.783
7								.695	.454	-.171	-.263	-.288	-.145	-.246
8									.337	-.080	-.226	-.346	-.235	-.076
9										-.308	-.357	-.358	-.331	-.249
10											.084	.068	-.017	.448
11												.140	.322	.150
12													.471	.011
13														.075
14														

LEGEND

1 chest girth
2 chronological age
3 flexed arm hang
4 grip strength (non-preferred hand)
5 grip strength (preferred hand)
6 height
7 manual dexterity (full board)
8 manual dexterity (partial)
9 shuttle run
10 skeletal age
11 standing broad jump
12 stork stand (eyes closed)
13 stork stand (eyes open)
14 weight

[illegible]

[illegible]

[illegible]

battery are meaningful but low.

As hypothesized, correlations among motor ability tests were low (Table II). Right and left grip strength means correlated .82, but this was expected as grip strength generally develops symmetrically. The partial and full board manual dexterity items were shown to be positively and significantly related (.69). The other motor ability test item in which speed was important, the shuttle run, resulted in a similar relationship (.45) with the full board manual dexterity test. Grip strength also correlated .45 (non-preferred hand) and .40 (preferred hand) with the shuttle run. The correlation between the two stork stand tests was .47. These tests may have measured different balance factors, since different forms of knowledge of results were utilized. However, as mentioned earlier, the stability of the stork stand tests was suspect.

All other relationships were low and only warrant observation of that fact.

Hypothesis 2: All measures of growth are significantly and positively related. As maturation and structure are somewhat different aspects of growth, the relationship among structural measures is higher than that between structural and maturation measures.

Correlations among structural measures were .62 (chest girth and height), .78 (height and weight) and .84 (chest girth and weight). The correlation between the two maturation indices used, chronological age and skeletal age, was in a similar direction but much lower (.33).

Correlations between skeletal age (maturation) and structural measures were significant and positive, but lower than those among structural measures. The .53 correlation between skeletal age and height was

the highest of the three.

Chronological age did not correlate as highly as skeletal age with the structural measures, though a meaningful relationship existed. Chronological age is, by itself, not a commonly used growth index (Espenschade, 1967). The wide variation among subjects in growth measures other than chronological age, was expected (Tanner, 1961; Johnson, 1964).

The data, therefore, supported the second hypothesis.

Hypothesis 3: Motor ability is not related to growth for young elementary school children of a single age group.

Approximately one-half of the correlations between growth and motor ability were significant (Table II); almost all of these were low, however.

The highest correlations were observed between grip strength and structural measures. A relationship between strength and structure was expected on the basis of the literature. Strength of preferred hand correlated .58, .55 and .54 with height, weight and chest girth respectively. Similar correlations were obtained between grip strength of the non-preferred hand and those anthropometric measures.

The shuttle run, standing broad jump and flexed arm hang tests were classified by Fleishman (1964) as strength measures. However, they did not produce a distinguishable relationship with structure. For the flexed arm hang, the lack of relationship was undoubtedly influenced by the large standard deviation found with the subjects in this study.

Growth did not appear to be an important factor in explaining motor ability differences of young children of a similar age.

Support was, therefore, offered for the third hypothesis.

Hypothesis 4: Motor ability is significantly related to socioeconomic

status for young school children.

Socioeconomic groups differed significantly in only one motor ability test, the flexed arm hang (Table III). The low socioeconomic subjects were superior in this item. However, the test cannot be considered indicative of general group difference because the standard deviations, particularly for the low group, were excessive.

Hypothesis 4 was rejected.

Hypothesis 5: Growth is positively related to socioeconomic status.

The difference in skeletal age between socioeconomic groups was small but significant (Table III). The high socioeconomic group had a higher mean skeletal age than the low socioeconomic group. Unfortunately, the credulousness of this finding was affected by a corresponding, though small, difference in mean chronological age. Also, the possibility existed that a racial factor may have influenced this result. The presence of a few Oriental subjects in the low socioeconomic group may have been responsible for the slightly lower mean skeletal age of this group. However, the existence of such a racial factor was doubtful. Greulich and Pyle (1959, p. 42) state:

> "the observed skeletal status of the California Japanese children does not support the view that the relative retardation of the children in Japan is attributable to some racial difference between Japanese and Caucasian children."

Differences between groups were expected to be greater for structural than for maturation measures; on the basis of the literature, structure appeared to be more easily influenced by environment than was maturation. This expectation was not observed in the present study.

TABLE III

MEANS, STANDARD DEVIATIONS AND T-VALUES OF ALL PARAMETERS FOR HIGH AND LOW SOCIOECONOMIC GROUPS

Parameter	Mean		Standard Deviation		Standard Error of Difference Between Means	T-Value
	High	Low	High	Low		
1. Chest girth (inches)	23.44	23.50	1.05	1.40	.279	-0.215
2. Chronological age (months)	83.52	82.59	3.43	4.06	.844	1.101
3. Flexed arm hang (seconds)	8.36	13.41	4.68	11.36	1.996	-2.529+
4. Grip strength - Non-preferred hand (kilograms)	9.76	9.08	2.04	2.28	.485	1.402
5. Grip strength - Preferred hand (kilograms)	10.40	9.80	2.19	2.41	.516	1.163
6. Height (inches)	48.06	47.31	1.66	2.21	.441	1.700
7. Manual dexterity - Full board (seconds)	117.02	118.59	11.62	12.48	2.698	-0.582
8. Manual dexterity - Partial (seconds)	20.23	20.43	2.39	2.32	.525	-0.381
9. Shuttle run (seconds)	15.66	15.97	1.40	1.28	.298	-1.040
10. Skeletal age (months)	73.77	68.92	11.34	10.50	2.429	1.996+
11. Standing broad jump (inches)	44.55	44.73	4.46	5.16	1.082	-0.166
12. Stork stand - Eyes closed (seconds)	6.86	7.03	4.72	4.27	.999	-0.170
13. Stork stand - Eyes open (seconds)	30.64	35.62	18.37	18.70	4.138	-1.204
14. Weight (pounds)	51.74	51.18	5.96	7.80	1.566	0.358

+ Significant at α = .05

The groups did not differ significantly in any of the structural measures. The greatest between-group difference in structure was observed for height (t = 1.7). Such a finding was consistent with the difference between groups in skeletal age, and the significant relationship (.53) between skeletal age and standing height.

According to Espenschade (1967), of all structural measures, weight is the best indicator of nutritional status. The absence of difference between groups in mean weight could have been indicative of the relative socioeconomic homogeneity of the total group. The reasons for such homogeneity were two-fold. First, the demographic information could have been ineffective as a basis for socioeconomic selection. Second, the groups, though truly from different socioeconomic strata, did not support Espenschade's statement nor the association of nutritional effects to socioeconomic class.

Hypothesis 5 (restated): Growth is positively related to socioeconomic status.

This hypothesis was not acceptable on the basis of the data (Table III), though the difference in skeletal age and height was in the predicted direction. For reasons stated above, or because socioeconomic groups in Edmonton were not sufficiently heterogeneous, the hypothesized differences in structure and maturation did not materialize.

Only four of the ninety-one correlations differed significantly between the high and low socioeconomic groups on growth and motor ability measures (Table IV). This number would be expected to occur by chance and, therefore, should not be considered as indicative of between-group differences in relationships among the growth and motor ability variables.

TABLE IV

ZERO ORDER CORRELATIONS BETWEEN ALL PARAMETERS FOR HIGH AND LOW SOCIOECONOMIC GROUPS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Low		.252	-.143	.628	.669	.763	-.166	-.066	-.383	.504	.325	.033	-.068	.874
	High		.318	.012	.473	.405	.451	-.392	-.318	-.185	.382	.011	.025	.068	.795
2	Low			-.056	.362	.350	.304	-.373	-.397	-.376	.253	.504	.108	-.028	.199
	High			.123	.262	.190	.509	-.329	-.187	-.267	.373	-.064	.161	.212	.237
3	Low				.021	-.028	-.102	-.035	.063	-.186	.086	.075	.173	.303	-.151
	High				.255	.414	.179	-.259	-.080	-.454	-.174	.260	.004	.346	-.013
4	Low					.803	.570	-.254	-.359	-.570	.334	.461	.282	.298	.626
	High					.835	.462	-.180	-.003	-.347	.153	.225	.111	.271	.493
5	Low						.665	-.100	-.185	-.339	.438	.177	.115	.035	.695
	High						.472	-.287	-.058	-.445	.169	.306	.083	.304	.394
6	Low							-.207	-.092	-.333	.645	.334	-.054	-.034	.904
	High							-.392	-.155	-.254	.398	.184	.087	.176	.625
7	Low								.627	.328	-.073	-.253	-.245	-.081	-.208
	High								.754	.554	-.235	-.277	-.329	-.225	-.290
8	Low									.304	-.046	-.204	-.254	-.163	-.039
	High									.358	-.092	-.252	-.416	-.309	-.115

LEGEND

1 chest girth
2 chronological age
3 flexed arm hang
4 grip strength (non-preferred hand)
5 grip strength (preferred hand)
6 height
7 manual dexterity (full board)
8 manual dexterity (partial)

.... continued on next page

TABLE IV (cont'd)

ZERO ORDER CORRELATIONS BETWEEN ALL PARAMETERS FOR HIGH AND LOW SOCIOECONOMIC GROUPS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
9	Low										-.310	-.548	-.331	-.255	-.337
	High										-.278	-.201	-.385	-.429	-.163
10	Low											.317	.104	-.077	.531
	High											-.110	.053	.084	.383
11	Low												.143	.268	.260
	High												.139	.378	.013
12	Low													.466	.002
	High													.479	.022
13	Low														.037
	High														.133
14	Low														
	High														

LEGEND

9 shuttle run
10 skeletal age
11 standing broad jump
12 stork stand (eyes closed)
13 stork stand (eyes open)
14 weight

T-values and standard scores comparing means and correlations of the socioeconomic groups with those of the total group (control), were similarly non-significant. This result further emphasized the apparent homogeneity of the total group.

Hypothesis 6: Maturation and structure are related, such that an advanced skeletal age is accompanied by a corresponding superiority in structure.

High and low skeletal age groups differed significantly in chest girth, height and weight (Table V). Members of the high skeletal age group exhibited superiority in those structural measures. This finding agreed with the accepted positive relationship between maturation and structure within the totality of the growth process; as such, Hypothesis 6 was supported.

Hypothesis 7: Skeletal age does not account significantly for motor ability differences among young elementary school children within one age group.

Skeletal age groups differed significantly in the hand grip and shuttle run items (Table V). The high skeletal age group had a greater grip strength and a lower shuttle run score than the low skeletal age group. As the hand grip and shuttle run items were classified by Fleishman (1964) as primarily tests of strength, the positive maturation-strength relationship found by Rarick and Oyster (1964) and Hindmarch (1962) was supported. This relationship may be extended to include structure, based on the grip strength-structure relationship referred to previously, and the significant and positive relationship found between maturation and structure in this and other studies (Hindmarch, 1962; Burt, 1962).

TABLE V

MEANS, STANDARD DEVIATIONS AND T-VALUES OF ALL PARAMETERS FOR HIGH AND LOW SKELETAL AGE GROUPS

Parameter	Mean High	Mean Low	Standard Deviation High	Standard Deviation Low	Standard Error of Difference Between Means	T-Value
1. Chest girth (inches)	23.90	23.14	1.31	1.04	0.269	2.822+
2. Chronological age (months)	84.23	82.24	3.83	3.47	0.825	2.412+
3. Flexed arm hang (seconds)	10.83	10.54	7.80	9.46	1.919	0.151
4. Grip strength - Non-preferred hand (kilograms)	10.17	8.90	2.43	1.78	0.487	2.605+
5. Grip strength - Preferred hand (kilograms)	10.76	9.64	2.39	2.13	0.512	2.189+
6. Height (inches)	48.52	47.10	1.88	1.80	0.414	3.430+
7. Manual dexterity - Full board (seconds)	115.14	119.72	9.06	13.55	2.517	-1.819
8. Manual dexterity - Partial (seconds)	20.09	20.50	2.28	2.40	0.523	-0.784
9. Shuttle run (seconds)	15.20	16.26	1.21	1.27	0.277	-3.823+
10. Skeletal age (months)	81.26	64.17	5.79	8.21	1.557	10.979+
11. Standing broad jump (inches)	45.00	44.35	5.27	4.38	1.100	0.591
12. Stork stand - Eyes closed (seconds)	7.23	6.72	5.03	4.08	1.042	0.490
13. Stork stand - Eyes open (seconds)	32.69	33.09	18.93	18.51	4.206	-0.095
14. Weight (pounds)	54.04	49.54	6.99	6.07	1.482	3.036+

+ Significant at $\alpha = .05$

According to Fleishman (1964), the standing broad jump and flexed arm hang are also tests of strength. However, no significant differences were found between the two skeletal age groups in these items.

Differences in motor ability between skeletal age groups were slight, and Hypothesis 7 was, for the most part, supported by the data. Hypothesis 7 and the above were similar to the statement and discussion of Hypothesis 3. Data concerning both of these hypotheses supported the following: firstly, lack of importance of growth as a factor influencing motor ability for very young children of a single age level; and secondly, a positive relationship among maturation, structure and strength.

It was important to observe that the conclusions concerning Hypotheses 6 and 7 must be regarded with caution. There was a significant difference between skeletal age groups in chronological age, in favour of the more mature group. Maturation-structure-motor ability relationships may have been influenced by this difference, as developmental curves are based on expected advancement in growth and motor ability with increasing chronological age.

Standard scores, comparing correlations of high and low skeletal age groups, were almost all insignificant (Table VI). The only notable observation was the more sizeable relationship between skeletal age and structural measures for the low skeletal age group. Further support was rendered for the homogeneity of the total experimental group.

Means and correlations of skeletal age groups were individually compared with those of the combined group (control). The number of significant standard scores was negligible. However, t ratios differed significantly for three variables. As arranged, groups differed from

TABLE VI

ZERO ORDER CORRELATIONS BETWEEN ALL PARAMETERS FOR HIGH AND LOW SKELETAL AGE GROUPS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Low		.192	-.052	.508	.600	.549	-.207	-.334	-.255	.441	.122	.046	-.124	.795
	High		.226	-.157	.494	.416	.602	-.268	.018	-.089	.111	.222	-.018	.132	.848
2	Low			.033	.276	.259	.295	-.225	-.271	-.191	.273	.267	.169	.169	.217
	High			-.159	.271	.212	.401	-.524	-.292	-.328	.105	.184	.075	-.027	.068
3	Low				.051	-.014	-.104	-.180	.024	-.219	-.078	.191	.124	.359	-.113
	High				.015	.158	-.072	.184	.032	-.215	-.226	.036	.079	.254	-.154
4	Low					.795	.486	-.163	-.349	-.444	.199	.298	.143	.099	.510
	High					.830	.483	-.231	.032	-.348	-.116	.367	.200	.441	.527
5	Low						.562	-.160	-.236	-.281	.361	.152	-.050	-.096	.600
	High						.537	-.179	.058	-.430	-.049	.297	.210	.455	.440
6	Low							-.140	-.208	-.043	.593	.226	-.066	-.017	.819
	High							-.471	.039	-.385	.158	.280	.050	.119	.686
7	Low								.696	.457	-.081	-.277	-.284	-.130	-.195
	High								.717	.360	.073	-.247	-.316	-.199	-.221
8	Low									.400	-.108	-.364	-.392	-.195	-.214
	High									.229	.152	-.061	-.294	-.293	.147

LEGEND

1 chest girth
2 chronological age
3 flexed arm hang
4 grip strength (non-preferred hand)
5 grip strength (preferred hand)
6 height
7 manual dexterity (full board)
8 manual dexterity (partial)

.... continued on next page

TABLE VI (cont'd)

ZERO ORDER CORRELATIONS BETWEEN ALL PARAMETERS FOR HIGH AND LOW SKELETAL AGE GROUPS

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
9	Low										-.017	-.340	-.350	-.336	-.125
	High										-.008	-.388	-.390	-.404	-.155
10	Low											.150	.106	.027	.517
	High											-.101	-.060	-.089	.031
11	Low												.134	.304	.097
	High												.140	.348	.171
12	Low													.432	-.053
	High													.518	.033
13	Low														-.008
	High														.186
14	Low														
	High														

LEGEND

9 shuttle run
10 skeletal age
11 standing broad jump
12 stork stand (eyes closed)
13 stork stand (eyes open)
14 weight

the control in skeletal age. In addition, the high skeletal age group deviated from the control group in height and shuttle run. Members of the more skeletally mature group had a significantly greater mean height and lower mean shuttle run time. The difference in weight between the high skeletal age and control groups was almost significant (t = 1.8). These results strengthened the support discussed previously, for the following hypotheses: a low relationship between skeletal age and motor ability for young children of a single age group; and a positive and meaningful relationship among maturation, structure and, if the shuttle run was considered to be a strength measure, strength also.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The purpose of this study was to investigate motor ability and physical growth levels, of two independent groups of Edmonton boys; groups were extreme with regard to socioeconomic status. The study was cross-sectional in nature, and is limited by that fact. Eighty-one, first grade male subjects, from six schools assigned by the Edmonton Public School Board, participated in the study. Forty-four subjects attended schools situated in reputedly high socioeconomic districts; thirty-seven subjects attended schools in low socioeconomic districts. Socioeconomic status of subjects was impressionistically supported by demographic data for the assigned school districts, regarding occupation, annual income and education of adult male residents.

The concept of motor ability has changed greatly in the last decade, and continues to change, as information about the complexity of motor performance and the specificity of underlying factors and abilities becomes available.

Though motor ability tests have developed from a weak theoretical foundation, they appear to constitute the entire basis of investigation of the motor development process. The following tests were selected for this study and administered in the schools:

1. Flexed Arm Hang
2. Hand Grip Strength - non-preferred hand
   - preferred hand

3. Manual Dexterity - full board
   - partial
4. Shuttle Run
5. Standing Broad Jump
6. Stork Stand - eyes closed
   - eyes open

Tests were employed to measure the motor performance factors of strength, balance and manual dexterity, and the gross motor abilities of running and jumping. All tests have been used in previous studies.

Growth includes the aspects of maturation and structure. Skeletal age, based on hand-wrist x-ray interpretation, is, at present, the most widely used index of maturation. Hand-wrist x-rays were employed in this study. Chronological age, the usual basis of growth norms, was also considered to be a maturation measure. Standing height, weight and chest girth were the structural measures which supplemented skeletal age. Height, weight and chest girth measurement was conducted by the investigator. X-rays were taken and interpreted by personnel at the University Hospital in Edmonton.

Physical growth and motor development parallel each other, in that advancement in both normally occurs with increased chronological age. According to the literature, however, levels of growth and motor ability do not appear to be significantly related for young elementary school children within one age group.

Heredity and environment play a part in the establishment of growth and motor development patterns. In sociological study, social

class or socioeconomic status is accepted as a source of environmental, and perhaps hereditary distinction. The concept of socioeconomic status seems to be embedded within the ideology and institutions of industrial societies the world over and, as such, is believed to have profound influence in the lives of members of these societies.

Associated with the various socioeconomic status levels are characteristic kinds of occupations, ranges of annual income and levels of education. Reference to these 'socioeconomic characteristics' provides a basis for assessment of socioeconomic status.

There appears to be a relationship between growth and socioeconomic status. According to the literature, lower status children have been found inferior to upper status children in growth. Measurement of growth was included in this study to assist in the interpretation of data relating motor ability and socioeconomic status.

Though documentation is sparce, it is possible that a relationship exists between socioeconomic status and motor ability. Characteristic social class differences in opportunity and kind of physical activity have been observed. In addition, performance differences between socioeconomic groups on motor tests have been found.

Motor ability and growth data for the eighty-one subjects was recorded on I.B.M. cards and treated in the following manner. Means, standard deviations and intercorrelation matrices were computed for the total experimental group, high and low socioeconomic groups, and high and low skeletal age groups. The significance of difference between means was determined by the calculation of t-values. A similar test was employed in the comparison of correlations, after transformation

to z-functions. Significance at the .05 level was considered acceptable for the purposes of this study.

Briefly, the results of the study were as follows:

1. Correlations among motor ability tests were low.
2. All growth measures were meaningfully related. Correlations among structural measures exceeded those between skeletal age (maturation) and structural measures.
3. Correlations between motor ability and growth measures were low.
4. Socioeconomic groups differed significantly in only two of the growth and motor ability measures; these were skeletal age and the flexed arm hang test. However, there were reasons to doubt these findings. The skeletal age difference was accompanied by a slight but corresponding difference in chronological age. Results of the flexed arm hang test were not stable, based on the excessively high standard deviations.
5. Correlations did not differ significantly for socioeconomic groups.
6. The means and correlations of the socioeconomic groups did not differ significantly from those of the total group (control).
7. Skeletal age groups differed significantly in the measures of chest girth, height, weight, shuttle run, grip strength and chronological age. The advanced structural level and greater strength of the high skeletal age group were regarded with caution, because of the corresponding chronological age difference.
8. A greater relationship between structure and skeletal age was observed for the low skeletal age group; otherwise, correlations did not differ significantly for skeletal age groups.

9. The high skeletal age group excelled in height and shuttle run measures, when compared to the total group (control). There was also a near-significant difference in weight, favoring the high skeletal age group. These findings were consistent with the results of the comparison between high and low skeletal age groups. However, a slight advantage in chronological age was again observed for the high skeletal age group.

Differences in correlations between the skeletal age groups and the total group (control) were attributed to chance.

Conclusions

The low relationship among motor ability tests was expected on the basis of related literature. Apparently, the tests measured different attributes of the performer. The attributes measured, termed factors or abilities, may influence performance in a variety of activities. As such, the results of the tests would provide an indication of motor ability. Knowledge of factors and abilities, believed to underlie motor performance, is extremely limited, however, and motor ability testing can be severely criticized for the weak theoretical base that exists. All that can be said of the test battery used in the present study, is that it appears to measure a sample of largely independent motor factors.

The significant correlations between structural and maturation measures, and the advanced structure of the high skeletal age group, are indicative of the positive relationship between the structural and

maturation aspects of growth. On the other hand, the degree of independence believed to exist between these two aspects was also substantiated in this investigation. Correlations among structural measures exceeded those between skeletal age and structure.

Although the processes of growth and motor development are undoubtedly interrelated somewhat, motor ability was not significantly related to structure or maturation for the subjects in this study. The lack of relationship between growth and motor ability evidenced by this and other studies of young children within a narrow age range, may be a result of the motor ability tests used.

The high skeletal age group exceeded the low skeletal age group in the shuttle run and hand grip items. Both items were classified by Fleishman (1964) as strength tests, though the shuttle run involves the motor ability of running. A growth-motor ability, or a growth-strength, relationship was thus suggested. However, these motor differences could not be attributed solely to advanced skeletal age, as the high skeletal age group also had a higher mean chronological age.

Within the limitations of this study, grade one boys from extreme socioeconomic environments in Edmonton did not differ in growth or motor ability. The homogeneity of the total group was consistently substantiated by the data. Results of the one motor ability test for which there was a significant difference between socioeconomic groups, were unstable. The barely significant skeletal age difference between groups was the only other notable observation.

Divergency in skeletal age for socioeconomic groups was as hypothesized, and it seems reasonable to speculate that with more extreme

socioeconomic groups, the difference, in favour of the high socioeconomic group, would be greater. However, the slight difference in chronological age, also in favour of the high socioeconomic group, must be taken into consideration. In addition, there was a lack of significant difference between socioeconomic groups in any of the structural measures, although the height difference neared significance in the predicted direction ($t = 1.7$); it does not seem reasonable to conclude that there were differences in maturation, but not in structure, as greater differences between socioeconomic groups were expected for structure than maturation. Therefore, the logical conclusion is that young elementary school boys from extreme socioeconomic environments in Edmonton did not differ significantly in growth and motor ability.

Recommendations

Motor development is a challenging area of study. The investigator suggests that more knowledge is required about the motor development process and the assessment of motor ability, before the effects of influential factors can be estimated with any degree of accuracy.

Efforts should be directed toward detailed analysis of motor skill performance. Factor analysis has proven useful, and could be pursued. Qualitative analysis is another promising approach, involving the study of movement patterns in terms of force, time and space characteristics. Films have been invaluable for the latter method of study.

Only when more is known about the stages of motor development, can valid means of assessment be established. Assessment may be

subjective or objective, but must rest on a foundation of knowledge of those movement aspects on which rating should be based.

In addition, it will probably prove more meaningful to study the relationship of specific factors, such as nutrition, health and practice to motor ability, rather than of such broad sources of distinction as socioeconomic status.

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APPENDIX A

DEMOGRAPHIC INFORMATION CONCERNING SOCIOECONOMIC CHARACTERISTICS OF ASSIGNED SCHOOL DISTRICTS* (ADULT MALES ONLY)

I UPPER STATUS SCHOOLS

		PROFESSIONAL STATUS			YEARS OF SCHOOLING				
	Total Number of Men	No. in Managerial & Professional Categories	% in Managerial & Professional Categories	Average Annual Income (Dollars)	Total	No. in One Year University to Degree	% in One Year University to Degree	No. in 3-5 Years High School	% in 3-5 Years High School
PARKVIEW	1094	638	58.3	6838.60	1463	325	22.2	447	30.6
GRANDVIEW	772	486	62.9	5785.50	875	312	35.7	233	26.6
CRESTWOOD	857	554	64.6	7279.60	1109	301	27.1	341	30.8

* Information in this table was drawn from 1961 demographic records for the City of Edmonton. The figures are totals for all enumeration areas completely and partly within the assigned school districts.

DEMOGRAPHIC INFORMATION CONCERNING SOCIOECONOMIC CHARACTERISTICS OF ASSIGNED SCHOOL DISTRICTS* (ADULT MALES ONLY)

II LOWER STATUS SCHOOLS

		PROFESSIONAL STATUS			YEARS OF SCHOOLING				
	Total Number of Men	No. in Managerial & Professional Categories	% in Managerial & Professional Categories	Average Annual Income (Dollars)	Total	No. in One Year University to Degree	% in One Year University to Degree	No. in 3-5 Years High School	% in 3-5 Years High School
ALEX TAYLOR	2187	206	9.4	2836.40	3770	109	2.9	591	15.7
NORWOOD	2886	315	10.9	3008.40	4216	184	4.4	712	16.9
McCAULEY	2059	127	6.2	2602.00	3065	86	2.8	387	12.6

* Information in this table was drawn from 1961 demographic records for the City of Edmonton. The figures are totals for all enumeration areas completely and partly within the assigned school districts.

APPENDIX B

COMMUNICATION WITH PARENTS

1. To parents in upper socioeconomic districts.

Room 202A, Physical Education Building
The University of Alberta, Edmonton
January 31, 1969

Dear

A study is to be conducted within Edmonton to investigate the physical maturation and motor ability levels of six year old boys. The boys are being chosen randomly from within the city. The Department of Elementary Education and the Assistant Principal of your child's school have approved of the study and are in full agreement with this request.

The study involves testing each child's ability to perform in selected large and small muscle coordination tasks. Children will be tested individually at school, with a total test time of approximately twenty minutes. Physical maturation will be determined by height and weight measures, and information from one hand-wrist x-ray. Assurance has been given by Dr. McConnell, Director of Radiology at the University Hospital, that "no significant radiation hazard is involved" in the single hand-wrist x-ray. X-rays will be taken during school time by qualified and registered x-ray technicians at the University Hospital. Under proper supervision, children will be transported to the University Hospital on special University of Alberta buses, which are insured for these purposes. The total time for the x-ray, and travel to and from the hospital will be approximately one and one-quarter hours.

I feel this is a worthwhile study, and I would like to have your cooperation in permitting your child to participate in the testing program. The results will indicate information about each child's physical developmental level. This information can, upon request, be made available to parents of children involved.

Please complete the form below and return it in the stamped self-addressed envelope as soon as possible. If you have any questions in regard to the study, do not hesitate to contact me through the University or at my home, 434-6564. Awaiting your reply, and sincerely hoping you will grant your permission, I remain,

Respectfully yours,

(Miss) Valerie Hunt, Graduate Student
Faculty of Physical and Health Education

- -

I will ______ permit ________________________________
(Name of Child -- Please Print)

will not ______

to participate in the testing program for the maturation and motor ability study outlined above.

Signed ________________________
(Parent or Guardian)

Date ________________________

2. To parents in low socioeconomic districts.

Room 202A, Physical Education Building
The University of Alberta, Edmonton
January 31, 1969

Dear

I would like to have your permission to give your six-year-old son a test. The test will measure his physical growth and his ability to run and jump. It will show his height and weight, and the size of his wrist bones. His wrist bones will be measured by an x-ray at the University Hospital. The x-ray is completely safe. The children will travel to the hospital together on a special bus. You can find out about your son's physical development and performance.

The school system has given permission for the study.

Please complete the form below and return it in the stamped, self-addressed envelope. If you have any questions, please call me at my home, 434-6564.

Thank you.

Yours sincerely,

(Miss) Valerie Hunt
Graduate Student
University of Alberta

- -

I will allow my son ______________________________
(Name of Child)

to take part in this program.

YES ______
NO ______
(Please ✓)

Signed ______________________________
(Parent or Guardian)

3. To parents in upper socioeconomic districts.

May 21, 1969

Dear

It has been some time since I received your permission to test the motor performance and maturation of your six (perhaps now seven) year old son. Motor performance testing was completed at the schools during April. Arrangements have now been finalized with your son's school and the University Hospital for the single hand-wrist x-ray for each boy. Your son and his classmates will be taken to the Hospital, by bus, on Thursday, May 22. The children will leave the school at approximately 1:30 p.m. and will return to the school at about 3:30 p.m.; they will be properly supervised throughout.

I realize that the children may be leaving school for home later than usual; however, we will see that the boys are escorted to their crosswalks.

Thank you again for your cooperation.

Sincerely,

(Miss) Valerie Hunt
University of Alberta

4. To parents in low socioeconomic districts.

May 22, 1969

Dear

It has been some time since I received your permission to test your six (perhaps now seven) year old son.

Running and jumping tests were given at the schools during April. Arrangements have now been made with your son's school and the University Hospital for the single x-ray of each boy's hand. Your son and his classmates will be taken to the Hospital by bus on Friday, May 23. The children will leave the school at approximately 1:30 p.m. and will return to the school at about 3:30 p.m.; they will be properly supervised throughout.

Thank you again for your cooperation.

Sincerely,

(Miss) Valerie Hunt
University of Alberta

APPENDIX C

RESULT SHEET

RESULT SHEET

NAME ________________________________

SCHOOL ______________________________

GROWTH AND MATURATION MEASURES

HEIGHT	WEIGHT	CHEST GIRTH (INS.)	CHRONOLOGICAL AGE (MOS.)	SKELETAL AGE (MOS.)

MOTOR ABILITY MEASURES

BROAD JUMP (INS.)	STORK STAND (SECS.)		SHUTTLE RUN (SECS.)	MANUAL DEXTERITY (SECS.)	GRIP STRENGTH (KGMS.)		FLEXED ARM HANG (SECS.)
	Eyes Open	Eyes Closed			Right	Left	

NOTE: Circle "right" or "left" in grip strength column to indicate preferred hand.

APPENDIX D

MOTOR ABILITY TEST BATTERY

Motor Ability Test Battery

General Instructions

1. Subjects are in street clothing and have bare feet for the performance of all tests.
2. If it is obvious to the test administrator that the child has not given his best effort in the performance of a trial, another trial may be given.
3. Due to the fact that two children are tested simultaneously using the same equipment, the order of test items is not set. However, tests are administered in the following groups:
    (a) Standing Broad Jump
    (b) Stork Stand
    Manual Dexterity
    Grip Strength
    (c) Flexed Arm Hang
    Shuttle Run
4. In the scoring of all but grip strength, half units are taken to the next highest whole number if the subject is attempting to get a high score, and to the next lowest whole number if a low score is considered good.

Description of Tests

1. Standing Broad Jump

Reliability: .90 (Fleishman, 1964; Keogh, 1965), .89 (Small, 1966)

Factor: explosive strength (Fleishman, 1964).

Ability: jumping.

Reference: Canadian Association for Health Physical Education and Recreation Fitness-Performance Test Manual (1966).

Equipment: Two four-foot tumbling mats, marked in inches and stabilized so that they do not slip.

Starting Position: The subject assumes a position on the mat, with toes behind the take-off line.

Performance: The subject is instructed to bend the knees and swing the arms, and to jump as far forward as possible.

Scoring: Measurement is in inches, to the nearest inch, from the take-off line to the back of the heel of the foot nearest the take-off line.

Reliability Controls: Five valid trials are allowed. Only the best trial will be used. If any part of the body touches behind the heels, the jump will be considered invalid and will be taken again. One practice trial may be given.

Comments: Children appeared to be motivated to perform well on this item. Almost all improved between the first and fifth trials. Wide variation in performance curves over the five trials was observed. More than five trials may be necessary for some children to reach a performance 'plateau'.

2. Stork Stand

Factor: static balance (Fleishman, 1964).

Reference: Lincoln-Oseretsky Motor Development Scale (Sloan, 1955).

Equipment: Stop watch and stocking.

Starting Position: The stocking is tied around the subject's hips. He then assumes a position with the sole of one foot against the inside of the supporting knee, and hand tucked into the stocking.

Performance: The subject is instructed to maintain the starting position for as long as possible. There is a maximum of 60 seconds per trial. Withdrawing the hands from the stocking, moving the supporting foot from the starting position, or touching the floor with the non-supporting foot, constitute the end of a trial. Rolling the weight on the supporting foot is allowed.

The stork stand will be performed three times with the eyes open, and three times with the eyes closed: a total of six trials.

Scoring: Measurement is in seconds, to the nearest second, from the assumption of the starting position until the termination of the trial. Three valid trials, a maximum of 60 seconds each, are allowed under each of the two conditions. The score of the best trial for each condition is used.

Reliability Controls: The subject may use either leg first as the supporting leg. For the second trial, he is instructed to use the other leg. For the third trial, he may use the leg of his choice. No practice trials are allowed.

Comments: It was often difficult to decide whether or not a trial should be terminated. Rolling the weight on the supporting foot most likely should not have been allowed. Fatigue may have been an influential factor in the performance of this item. Many children appeared to lose concentration while performing, sometimes

resulting in a poor trial.

3. Manual Dexterity

Factor: Manual dexterity (Fleishman, 1964).

Reference: Minnesota Rate of Manipulation Test (Fleishman, 1964).

Equipment: A sixty-four hole peg-board and a box of pegs, on a table two-and-one-half feet high. One stop watch.

Starting Position: The subject stands facing the board on the table. His preferred hand is placed flat on the table beside the peg box. His other hand is at his side.

Performance: The subject is instructed to begin, on the signal, to transfer pegs from the box to the holes in the peg-board, until there is a peg in each hole. He must pick up one peg at a time, using only his preferred hand. He is directed to fill the board as quickly as possible. The subject is free to choose his own pattern of placing pegs.

The subject will perform two tests:

A. Full Board Test.

All sixty-four holes must be filled.

B. Partial Test.

The twelve holes at the end of the board closest to the preferred hand must be filled. All other holes are covered.

Scoring: Measurement is in seconds, to the nearest second, from the signal to begin until the last hole is filled.

Reliability Controls: Placement of pegs is demonstrated. The subject may place a few practice pegs. One trial is allowed for

each test. If a performance error is made shortly after the beginning of the full board test, the subject is told to stop and begin again. Attempts to compensate for other performance errors in the full board test are made by the addition or subtraction of one or two seconds. Errors during performance of the partial test render the trial invalid, and another trial is given. Verbal encouragement and reminders of performance rules are given during performance.

Comments: The table was slightly high for the young subjects in this study. Also, the full board test was too long. An obvious reduction in speed accompanied apparent fatigue and loss of motivation on the part of the children. Due to the length of time for performance of the full board test, second trials were not usually feasible. Adjustments in score were necessary for errors made other than at the beginning of this test. The partial test appeared to be better suited to the subjects in this study.

4. Grip Strength

Reliability: .91 (Fleishman, 1964), .85 right grip and .79 left grip (Keogh, 1965).

Factor: static strength (Fleishman, 1964).

Reference: Physical Fitness Index (Clarke, 1959), and the Examiner's Manual, Smedley Hand Dynamometer.

Equipment: Smedley adjustable grip dynamometer and a ruler marked in centimeters.

Starting Position: The distance, in centimeters, from where the thumb joins the hand to the end of the longest finger is measured.

The grip is adjusted to the scale position on the outer stirrup equal to one-half of the measured distance. The joint between the proximal and middle phalanx should fit over the inner stirrup of the dynamometer. The subject stands pointing the dynamometer forward, with his arm straight and wrist vertical (neither pronated nor supinated). The dial faces away from the subject.

Performance: The subject is instructed to squeeze on command, as hard as possible, using one hand only. He should carry the dynamometer down to, but not touching, the side of his body during the squeeze. The arm should remain straight and the wrist vertical. The subject performs three trials with each hand, alternating hands. A brief rest is allowed between each squeeze while the reading from the dynamometer is recorded. The rest between the second and third trial for each hand is longer; other tests are performed during this time.

Scoring: Measurement is in kilograms, to the nearest half kilogram.

Reliability Controls: Performance of the test is demonstrated. Verbal encouragement is given during each trial. Only the best of the three scores for each hand is used.

Comments: Subjects displayed interest in this item, and appeared to give a good effort. Some leeway was given regarding twisting of the wrist and bending of the arm during performance.

5. Flexed Arm Hang

Reliability: .77 (Fleishman, 1964).

Factor: dynamic strength (Fleishman, 1964).

Reference: Canadian Association for Health, Physical Education

and Recreation Fitness-Performance Test Manual (1966).

Equipment: A doorway gym bar, placed four-and-one-half feet from the floor, and a stop watch.

Starting Position: The subject reverse grasps the bar (palms towards face), and is assisted in pulling himself to the bar, so that his eyes are at the level of the bar. The arms are fully flexed.

Performance: The subject holds himself in this hanging position for as long as he is able.

Scoring: The total period of time that the subject can maintain the exact position is determined to the nearest second.

Reliability Controls: The subject must keep the bridge of his nose at the bar. A picture illustrating the hanging position is shown to each subject. One trial is allowed. Errors are corrected quickly during performance. Verbal encouragement is given. The test terminates when the subject's head drops below the level of the bar.

Comments: It was obvious to the investigator that many subjects did not perform as they were capable on this item. A common error was hanging with the chin above rather than below the bar. Second trials were undesirable under any circumstances because of the influence of fatigue.

6. Shuttle Run

Reliability: .85 (Fleishman, 1964), .73 (Keogh, 1965).

Factor: explosive strength (Fleishman, 1964).

Ability: running.

Reference: Canadian Association for Health, Physical Education and Recreation Fitness-Performance Test Manual (1966).

Equipment: Two wooden blocks (4" x 1-1/2" x 1-5/8") and a stop watch. Lines marking out a 30 foot distance.

Starting Position: The subject lies face down, hands at the sides of the chest and forehead on the starting line.

Performance: On the signal, the subject jumps to his feet and runs thirty feet to the line. He must pick up one block of wood, return to the starting line, and place the block behind this line. He then returns to the second line, picks up the second block of wood, and runs back to the finish line. He is instructed to carry the block behind the finish line.

Scoring: Measurement is in seconds, to the nearest second, from the starting signal until the subject crosses the finish line.

Reliability Controls: A 'ready' signal is given prior to the starting signal. Two trials, with a brief rest between are allowed. The score of the better trial is used. Verbal direction and encouragement is given during performance.

Comments: There was some difficulty in making the instructions for this item understood. Many subjects slowed down noticeably just prior to crossing the finish line. Also, scoring should have been to the nearest tenth of a second.

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